

भारतीय मानक

सामान्य उत्थापन प्रयोजनों के लिए
फोर्जित-शैकल — डी शैकल और धनु शैकल
(पहला पुनरीक्षण)

Indian Standard

FORGED SHACKLES FOR GENERAL
LIFTING PURPOSES — DEE SHACKLES
AND BOW SHACKLES

(First Revision)

ICS 53.020.30

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NATIONAL FOREWORD

This Indian Standard (First Revision) which is identical with ISO 2415 : 1987 'Forged shackles for general lifting purposes — Dee shackles and bow shackles' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendations of the Cranes, Lifting and Its Related Equipment Sectional Committee and approval of the Mechanical Engineering Division Council.

The standard IS 6132 (Part 1) was first issued in 1971 and IS 6132 (Part 2) and IS 6132 (Part 3) were published in 1972. Considerable assistance was taken from ISO 2415 : 1973 'Forged shackles for general lifting purposes — Dee shackles and bow shackles'. Since ISO revised its edition in 1987, it has become necessary to revise this standard also in line with the International Standard. In this revision, all the three parts have been merged into a single standard. This revision is identical with ISO 2415 : 1987.

The text of ISO Standard has been approved as suitable for publication as Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

- Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.
- Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their place are listed below along with their degree of equivalence for the editions indicated:

<i>International Standard</i>	<i>Corresponding Indian Standard</i>	<i>Degree of Equivalence</i>
ISO 261 ISO general purpose metric screw threads — General plan	IS 4218 (Part 2) : 2001 ISO metric screw threads: Part 2 Diameter pitch combinations (<i>first revision</i>)	Identical
ISO 643 Steels — Micrographic determination of the ferritic or austenitic grain size	IS 4748 : 1988 Method for estimating average grain size of metals (<i>first revision</i>)	Modified
ISO 4948-1 Steel — Classification — Part 1: Classification of steels into unalloyed and alloy steels based on chemical composition	IS 7598 : 1988 Classification of steels (<i>first revision</i>)	do
ISO 6506 Metallic materials — Hardness test — Brinell test	IS 1500 : 1983 Methods for Brinell hardness test for metallic materials (<i>second revision</i>)	do
ISO 6508 Metallic materials — Hardness test — Rockwell test (scales A – B – C – D – E – F – G – H – K)	IS 1586 : 2000 Method for Rockwell Hardness test for metallic material (scales A – B – C – D – E – F – G – H – K 15N, 30N, 15T, 30T and 45T) (<i>third revision</i>)	do

(Continued on third cover)

Indian Standard

**FORGED SHACKLES FOR GENERAL
LIFTING PURPOSES — DEE SHACKLES
AND BOW SHACKLES**

(First Revision)

1 Scope and field of application

This International Standard specifies the general characteristics, performance and critical dimensions necessary for interchangeability and compatibility with other components, of forged dee and bow shackles in a range of sizes having working load limits from 0,63 to 100 t, and in grades M(4), S(6) and T(8).

In the case of dee shackles for use with forged steel lifting hooks (see ISO 4779 and 7597), it may be necessary to use an intermediate component to make the connection.

2 References

ISO 261, *ISO general purpose metric screw threads — General plan*.

ISO 263, *ISO inch screw threads — General plan and selection for screws, bolts and nuts — Diameter range 0.06 to 6 in.*

ISO 643, *Steels — Micrographic determination of the ferritic or austenitic grain size*.

ISO 4779, *Forged steel lifting hooks with point and eye for use with steel chains of grade M(4)*.

ISO 4948-1, *Steel — Classification — Part 1: Classification of steels into unalloyed and alloy steels based on chemical composition*.

ISO 6506, *Metallic materials — Hardness test — Brinell test*.

ISO 6508, *Metallic materials — Hardness test — Rockwell test (scales A — B — C — D — E — F — G — H — K)*.

ISO 7597, *Forged steel lifting hooks with point and eye for use with steel chains of grade T(8)*.

3 Definitions

For the purposes of this International Standard, the following definitions apply. See also figures 1 and 2.

3.1 shackle: A component consisting of two readily separable parts, the body and the pin.

3.2 body: One of the two parts of the shackle, consisting of a bar of suitable section formed through an appropriate angle (see 3.6 and 3.7) and terminating in coaxial eyes.

3.3 crown: The part of the shackle body opposite the pin.

3.4 eyes: Bosses on the ends of the body with coaxial holes through which the pin passes.

3.5 pin: A straight bar of circular section which passes through the eyes, arranged so as to be secure when in position and which can be readily disassembled. (See figures 1, 2 and 3.)

3.6 dee shackle: A shackle the crown of which forms a semicircle of internal radius half the width, W , between the eyes. (See figure 1.)

3.7 bow shackle: A shackle the crown of which forms more than a semicircle of internal radius more than half the width, W , between the eyes. (See figure 2.)

3.8 ultimate strength: The maximum force reached during tensile testing of a shackle at the end of which the shackle fails to retain the load.

3.9 proof force, F_p : The force applied as a test to a finished shackle as specified in clause 13.

3.10 working load limit (WLL): The maximum mass which a shackle is designed to sustain in general service.

3.11 working load (WL): The maximum mass which a shackle may sustain in a particular stated service.

4 Forms and dimensions

4.1 Dee shackles

The dimensions of dee shackles shall comply with the requirements laid down in table 1 and figure 1.

4.2 Bow shackles

The dimensions of bow shackles shall comply with the requirements laid down in table 2 and figure 2.

4.3 Hole diameter

The diameter of the unthreaded hole or holes in the body of the shackle shall not exceed the following values:

- a) Hole diameter for pins having a diameter up to and including 20 mm: $D + 1$ mm
- b) Hole diameter for pins having a diameter over 20 mm and up to and including 45 mm: $D + 1,5$ mm
- c) Hole diameter for pins having a diameter over 45 mm: $D + 2$ mm

where D is the actual pin diameter.

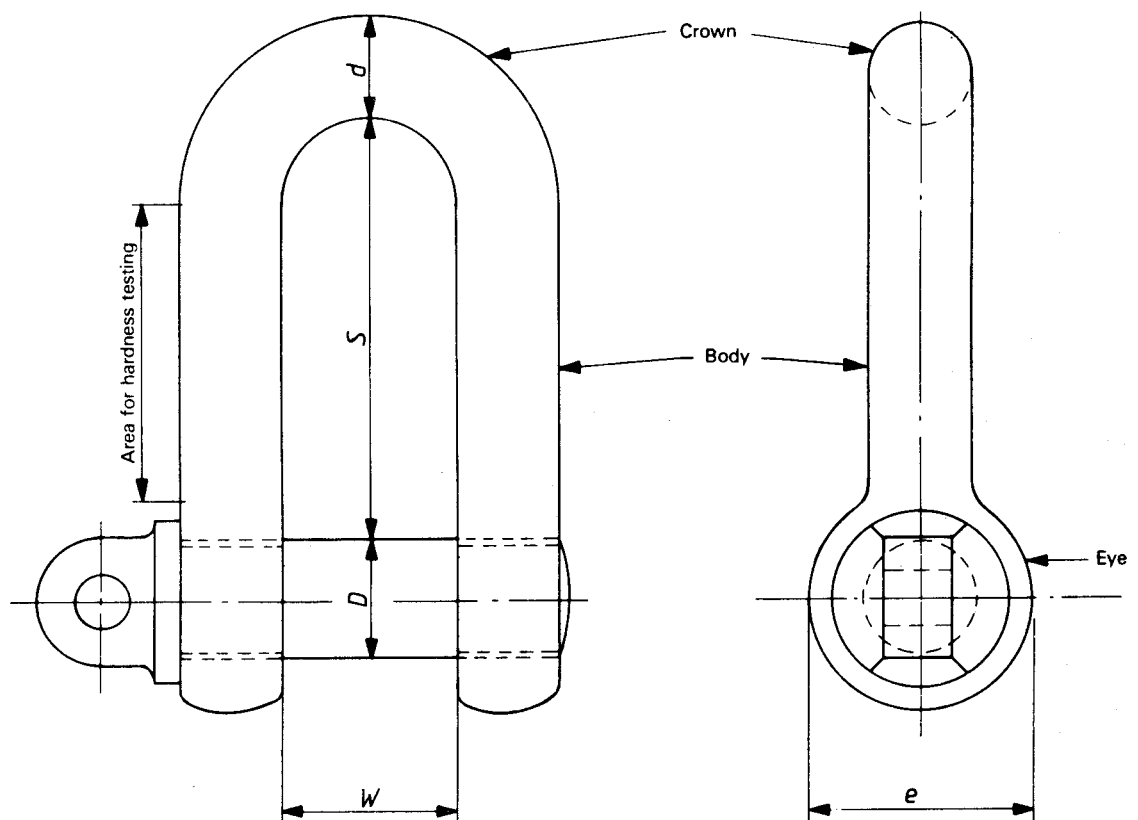


Figure 1 — Dimensions of dee shackles

Table 1 — Dimensions of dee shackles

Working load limit for grades			$d^{(1)}$ max.	$D^{(2)}$ max.	e max.	$S^{(3)}$ min.	$W^{(2)}$ min.
M(4)	S(6)	T(8)					
t			mm	mm		mm	mm
—	—	0,63	8	9	2,2 D max.	18	9
—	0,63	0,8	9	10		20	10
—	0,8	1	10	11,2		22,4	11,2
0,63	1	1,25	11,2	12,5		25	12,5
0,8	1,25	1,6	12,5	14		28	14
1	1,6	2	14	16		31,5	16
1,25	2	2,5	16	18		35,5	18
1,6	2,5	3,2	18	20		40	20
2	3,2	4	20	22,4		45	22,4
2,5	4	5	22,4	25		50	25
3,2	5	6,3	25	28		56	28
4	6,3	8	28	31,5		63	31,5
5	8	10	31,5	35,5		71	35,5
6,3	10	12,5	35,5	40		80	40
8	12,5	16	40	45		90	45
10	16	20	45	50		100	50
12,5	20	25	50	56		112	56
16	25	32	56	63		125	63
20	32	40	63	71		140	71
25	40	50	71	80		160	80
32	50	63	80	90		180	90
40	63	—	90	100		200	100
50	80	—	100	112		224	112
63	100	—	112	125		250	125
80	—	—	125	140		280	140
100	—	—	140	160		315	160

1) Formulae used to calculate values of d max. :

- M(4) : $14\sqrt{WLL}$
- S(6) : $11,2\sqrt{WLL}$
- T(8) : $10\sqrt{WLL}$

2) Formulae used to calculate values of D max. and W min. :

- M(4) : $16\sqrt{WLL}$
- S(6) : $12,5\sqrt{WLL}$
- T(8) : $11,2\sqrt{WLL}$

3) Formulae used to calculate values of S min. :

- M(4) : $31,5\sqrt{WLL}$
- S(6) : $25\sqrt{WLL}$
- T(8) : $22,4\sqrt{WLL}$

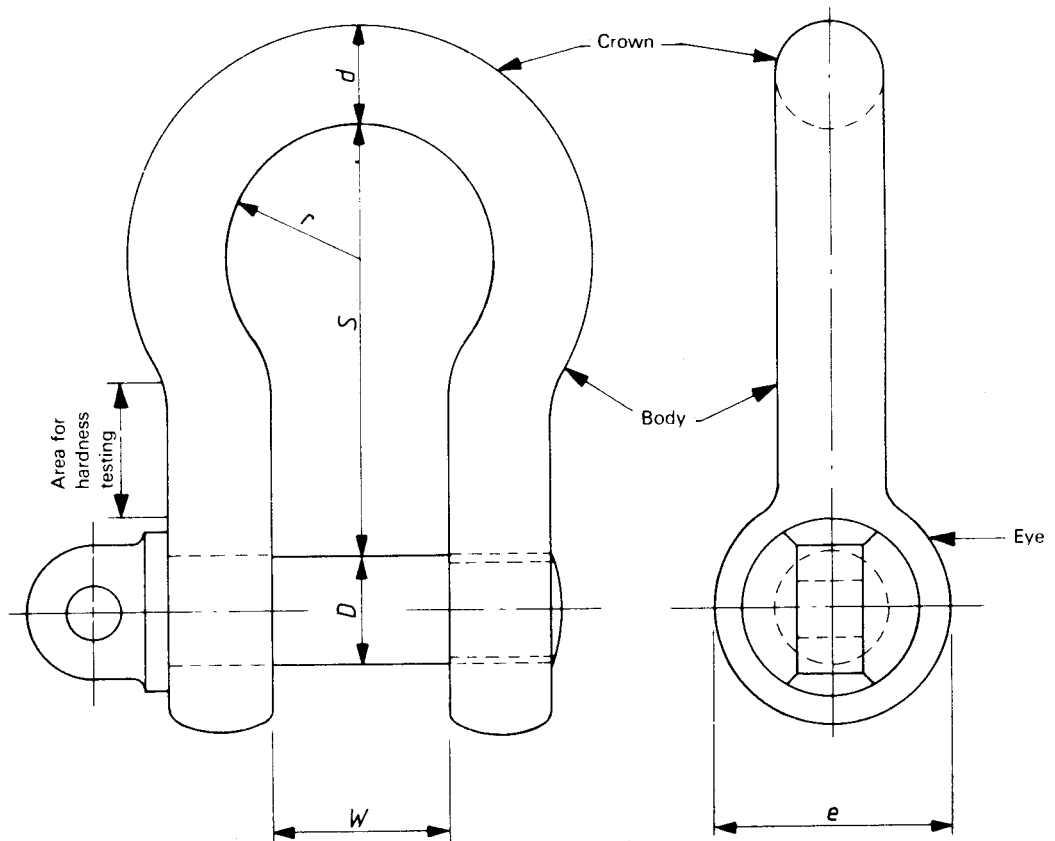


Figure 2 — Dimensions of bow shackles

Table 2 — Dimensions of bow shackles

Working load limit for grades			$d^{1)}$	$D^{2)}$	e	$2r^{3)}$	$S^{4)}$	$W^{2)}$
M(4)	S(6)	T(8)	max.	max.		min.	min.	min.
t			mm	mm	2,2 D max.	mm	mm	mm
—	—	0,63	9	10		16	22,4	10
—	0,63	0,8	10	11,2		18	25	11,2
—	0,8	1	11,2	12,5		20	28	12,5
0,63	1	1,25	12,5	14		22,4	31,5	14
0,8	1,25	1,6	14	16		25	35,5	16
1	1,6	2	16	18		28	40	18
1,25	2	2,5	18	20		31,5	45	20
1,6	2,5	3,2	20	22,4		35,5	50	22,4
2	3,2	4	22,4	25		40	56	25
2,5	4	5	25	28		45	63	28
3,2	5	6,3	28	31,5		50	71	31,5
4	6,3	8	31,5	35,5		56	80	35,5
5	8	10	35,5	40		63	90	40
6,3	10	12,5	40	45		71	100	45
8	12,5	16	45	50		80	112	50
10	16	20	50	56		90	125	56
12,5	20	25	56	63		100	140	63
16	25	32	63	71		112	160	71
20	32	40	71	80		125	180	80
25	40	50	80	90		140	200	90
32	50	63	90	100		160	224	100
40	63	—	100	112		180	250	112
50	80	—	112	125		200	280	125
63	100	—	125	140		224	315	140
80	—	—	140	160		250	355	160
100	—	—	160	180		280	400	180

1) Formulae used to calculate values of d max. :

- M(4) : $16\sqrt{WLL}$
- S(6) : $12,5\sqrt{WLL}$
- T(8) : $11,2\sqrt{WLL}$

2) Formulae used to calculate values of D max. and W min. :

- M(4) : $18\sqrt{WLL}$
- S(6) : $14\sqrt{WLL}$
- T(8) : $12,5\sqrt{WLL}$

3) Formulae used to calculate values of $2r$ min. :

- M(4) : $28\sqrt{WLL}$
- S(6) : $22,4\sqrt{WLL}$
- T(8) : $20\sqrt{WLL}$

4) Formulae used to calculate values of S min. :

- M(4) : $40\sqrt{WLL}$
- S(6) : $31,5\sqrt{WLL}$
- T(8) : $28\sqrt{WLL}$

5 Mechanical properties

5.1 General

The mechanical properties of the shackles in terms of proof force and ultimate strength shall be as specified in table 3.

5.2 Proof force

Each shackle, tested in accordance with 12.2, shall be capable of sustaining the proof force specified in table 3 without permanent deformation of the pin, which, after loosening, shall turn freely, and without an increase in the actual dimension, S , of the shackle body or in a similar dimension measured between punch marks on the pins and the crown, exceeding 0,25 % or 0,5 mm, whichever is the greater.

5.3 Ultimate strength

Each shackle, tested in accordance with 12.3, shall have an ultimate strength at least equal to that specified in table 3 without fracture or distortion to the extent that the shackle becomes incapable of retaining the load.

On completion of the test, each shackle shall show evidence of ductility.

5.4 Fatigue resistance [grades S(6) and T(8)]

Shackles with a working load limit up to and including 10 t, when tested in accordance with 12.4, shall, after at least 10 000 cycles, be capable of retaining the load.

Table 3 — Mechanical properties

Working load limit (WLL)	Proof force F_e	Minimum ultimate strength
t	kN	kN
0,63	12,5	25
0,8	16	32
1	20	40
1,25	25	50
1,6	32	63
2	40	80
2,5	50	100
3,2	63	125
4	80	160
5	100	200
6,3	125	250
8	160	320
10	200	400
12,5	250	500
16	320	630
20	400	800
25	500	1 000
32	630	1 250
40	800	1 600
50	1 000	2 000
63	1 250	2 500
80	1 600	3 200
100	2 000	4 000

6 Material

6.1 Grade M(4)

6.1.1 General

The steel shall be produced by the open-hearth, the electric or an oxygen-blown process.

In its finished state, as supplied to the shackle manufacturer, the steel shall comply with the requirements specified in 6.1.2, as determined by a cast or check analysis on the bar or on the finished shackle. The manufacturer should supply a cast analysis of the steel if required by the purchaser.

6.1.2 Specific requirements

The steel shall be fully killed, shall be suitable for forging and shall be capable of being heat treated to obtain the mechanical properties required by this International Standard.

Its content of sulfur and phosphorus shall be restricted as specified in table 4.

Table 4 — Sulfur and phosphorus content [grade M(4)]

Element	Maximum content, % (m/m), as determined by	
	cast analysis	check analysis
Sulfur	0,045	0,05
Phosphorus	0,04	0,045

The steel shall be made in conformity with fine grain practice in order to obtain an austenitic grain size of 5 or finer when tested in accordance with ISO 643. This could be achieved, for example, by ensuring that it contains sufficient aluminium or an equivalent element to permit the manufacture of shackles stabilized against strain-age embrittlement during service; a minimum value of 0,02 % (m/m) of metallic aluminium is given for guidance.

Within the limitations specified above, it is the responsibility of the shackle manufacturer to select steel so that the finished shackle, suitably heat-treated, complies with the requirements for the mechanical properties specified in this International Standard for the appropriate grade of shackle.

6.2 Grades S(6) and T(8)

6.2.1 General

The steel shall be produced by the open-hearth, the electric or an oxygen-blown process.

In its finished state, as supplied to the shackle manufacturer, it shall comply with the requirements specified in 6.2.2, as determined by a cast or check analysis on the bar or on the finished shackle. The manufacturer should supply a cast analysis of the steel if required by the purchaser.

6.2.2 Specific requirements

The steel shall be fully killed, shall be suitable for forging and shall contain alloying elements in sufficient quantities to guarantee the mechanical properties of the shackle after appropriate heat treatment.

The steel for grade S(6) shackle bodies shall contain at least one of the following elements, in the alloying proportions specified in ISO 4948-1:

- nickel;
- chromium;
- manganese;
- molybdenum.

The steel for grade S(6) shackle pins shall contain at least one of the following elements, in the alloying proportions specified in ISO 4948-1:

- nickel;
- chromium;
- molybdenum.

The steel for grade T(8) shackles shall contain at least two of the following elements, in the alloying proportions specified in ISO 4948-1:

- nickel;
- chromium;
- molybdenum.

Its content of sulfur and phosphorus shall be restricted as specified in table 5.

**Table 5 — Sulfur and phosphorus content
[grades S(6) and T(8)]**

Element	Maximum content, % (m/m), as determined by	
	cast analysis	check analysis
Sulfur	0,035	0,04
Phosphorus	0,035	0,04

The steel shall be made in conformity with fine grain practice in order to obtain an austenitic grain size of 5 or finer when tested in accordance with ISO 643. This could be achieved, for example, by ensuring that it contains sufficient aluminium or an equivalent element to permit the manufacture of shackles stabilized against strain-age embrittlement during service; a minimum value of 0,02 % (m/m) of metallic aluminium is given for guidance.

Within the limitations specified above, it is the responsibility of the shackle manufacturer to select steel so that the finished shackle, suitably heat-treated, complies with the requirements for mechanical properties specified in this International Standard for the appropriate grade of shackle.

7 Heat treatment

7.1 Grades M(4) and S(6)

After forging, the shackle shall be subjected to a suitable heat treatment, account being taken of the material and the mechanical properties required.

7.2 Grade T(8)

After forging, the shackle shall be hardened and tempered, account being taken of the material and the mechanical properties required.

Grade T(8) shackles can be used up to a maximum temperature of 400 °C without impairment or change to their metallurgical and mechanical properties when returned to room temperature. When required, for verification, sample shackles shall be tested after they have been re-heated to 400 °C, maintained at that temperature for 1 h, and then cooled to room temperature.

NOTE — Any heat treatment should be carried out only by the manufacturer or after reference to the manufacturer.

8 Hardness

8.1 Hardness requirement

The hardness values of shackles shall not exceed the values specified in table 6.

Table 6 — Hardness values

Grade	Brinell hardness HBS	Rockwell hardness HRC
M(4)	217	17
S(6)	300	32
T(8)	380	41

8.2 Hardness testing

In order to determine Brinell hardness numbers, the tests shall be carried out in accordance with ISO 6506 using, where practicable, a 10 mm steel ball and a force of 29,42 kN (HBS 10/3 000).

In order to determine Rockwell C hardness numbers, the tests shall be carried out in accordance with ISO 6508.

Other methods of determining hardness may be used provided the values obtained, when converted to equivalent Brinell or Rockwell C values, comply with the requirements laid down in 8.1.

The surface on which the impression is to be made shall be obtained by filing, grinding or smooth machining, and shall be in a suitable position (as shown in figures 1 and 2).

Suitable precautions should be taken to ensure that the surface tested is representative of the material and that its hardness is not affected by decarburizing, carburization or by the method used for preparing the test surface.

9 Types of shackle pin

The threaded shackle pins shown in figure 3 illustrate only typical examples of pins and other suitable forms of pin are acceptable:

The pins illustrated are of the following types:

- Type W: screwed with eye and collar
- Type X: bolt with hexagon head, hexagon nut and split cotter pin
- Type Y: countersunk and slotted head

Other types of pin are designated as being of type Z for the purposes of the designation system (see clause 16).

10 Workmanship

The body shall be forged in one piece without welding. Holes in shackle bodies shall be aligned axially with each other and centrally to the outside diameter of the eyes.

The pin shall be either forged and machine-finished, as necessary, machined from the bar, or, subject to agreement between purchaser and manufacturer, as forged and suitably finished. The screwed portion of the pin shall be concentric with the main portion. The collar or head of the pin shall fit closely against the body of the shackle.

When a threaded pin is fully tightened, the length of thread which remains visible between the jaws of the shackle shall not be greater than one thread (e.g. in the case of types W and Y pins).

The length of the plain portion of the bolt shall be such that when the nut is screwed onto the bolt, it seats onto the shoulder of the bolt and not on the shackle body (e.g. in the case of the type X pin).

In all cases when the pin is correctly fitted in the body of the shackle, the jaw width, W , shall not be significantly reduced.

The finished shackle body and pin shall be free from any harmful surface defects, including cracks.

11 Screw threads

Unless otherwise specified screw threads shall conform to either ISO 261 or ISO 263 and they shall be class 6g/6H (medium fit).

Alternative forms of thread may be used provided that the strength of the shackle is not impaired.

12 Type testing

12.1 General

Type tests demonstrate that shackles certified by the manufacturer as complying with the requirements laid down in this International Standard possess the mechanical properties specified in this International Standard. The purpose of these tests is to prove the design, material, heat treatment and method of manufacture of each size of finished shackle, including protective coating, if applied. Any change in the design, material specification, heat treatment, method of manufacture, including protective coating, if applied, or in any dimension outside normal manufacturing tolerances which may lead to a modification of the mechanical properties as defined in clause 5 shall require that the type tests specified in 12.2 to 12.4 be carried out on the modified shackle.

All shackles to be type tested shall comply with all the other requirements laid down in this International Standard. The tests specified in 12.2 to 12.4 shall be carried out on each size of shackle of each design, material, heat treatment and method of manufacture, including protective coating, if applied.

In the tests specified in 12.2 to 12.4, the force shall be applied axially without shock to the crown of the body, using a test machine fitting having a diameter not greater than the actual diameter of the shackle pin, and to the centre of the shackle pin, using a test machine fitting having a width not exceeding the actual diameter of the pin.

12.2 Deformation test

Three samples shall be tested and each shall be capable of sustaining the proof force specified for the shackle in table 3.

After the test force has been removed, the pin shall show no permanent deformation and, after it has been loosened, it shall turn freely. The actual dimension, S , or a similar dimension measured between punch marks on the pin and the crown shall not increase by more than 0,25 % or 0,5 mm, whichever is the greater.

NOTE — See also clause 13 for proof testing of shackles, where required.

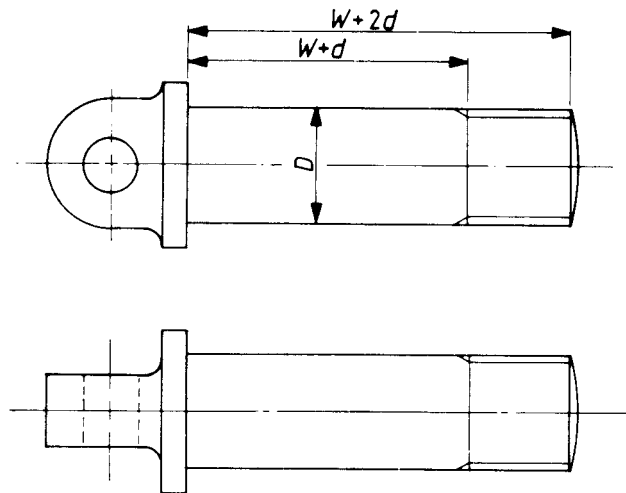
12.3 Static strength test

12.3.1 WLL < 63 t

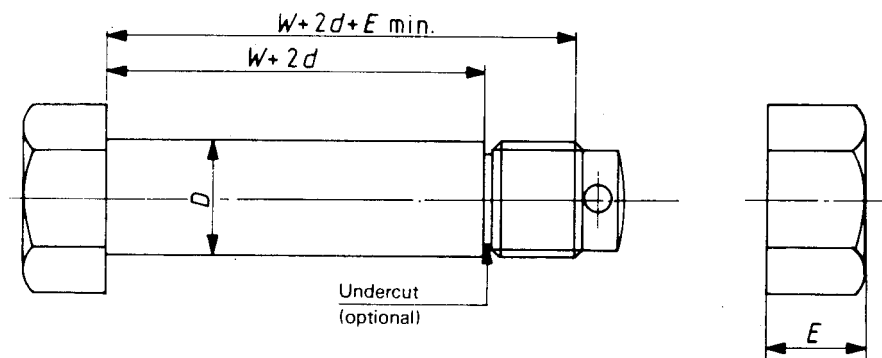
NOTE — This test may be carried out on the same shackles that have been submitted to the deformation test.

Three samples shall be tested and each shall have an ultimate strength at least equal to the minimum value specified for the shackle in table 3.

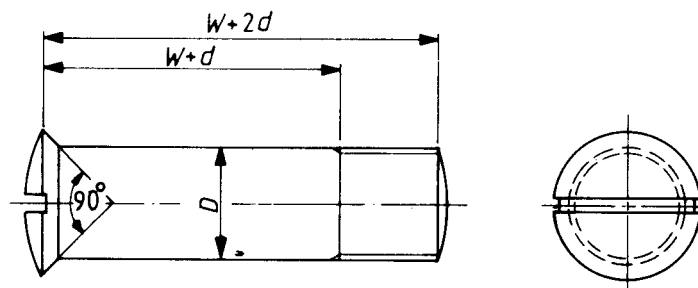
Each shackle body and pin shall be capable of withstanding the force without fracture or distortion to the extent that the shackle becomes incapable of retaining the load.



a) Type W: Screwed with eye and collar



b) Type X: Bolt with hexagon head, hexagon nut and split cotter pin



c) Type Y: Countersunk and slotted head

Figure 3 — Typical examples of shackle pin types

12.3.2 WLL > 63 t

For shackles with a working load limit of over 63 t, the ultimate strengths may be verified by calculation provided that the shackles are of the same geometrical design and are the same in other respects as those shackles with a working load limit of up to and including 63 t, which have been tested in accordance with 12.3.1. An example of a method of design is given in the annex.

12.4 Fatigue tests [Grades S(6) and T(8) : WLL ≤ 10 t]

Shackles with a working load limit of up to and including 10 t shall be subjected to the fatigue test. Three samples shall be tested.

The force range applied during each cycle shall be equal to 0,75 times the proof force specified in table 3 for the shackle. The minimum force in each cycle shall be positive and less than or equal to 3 kN. The frequency of force application shall be between 5 and 25 Hz. The samples tested shall be capable of sustaining at least 10 000 cycles of the force range specified above without failing to retain the load.

12.5 Acceptance criteria for type testing

12.5.1 Deformation test (see 12.2)

All three samples tested shall pass the deformation test in order for the shackle of the size submitted for type testing to comply with this International Standard.

12.5.2 Static strength test and fatigue test (see 12.3 and 12.4)

If all three samples pass the test, the shackle of the size submitted for type testing complies with this International Standard.

If one of the samples fails, two further samples shall be tested and both shall pass the test in order for the shackle of the size submitted for type testing to comply with this International Standard.

If two or three samples fail the test, the shackle of the size submitted for type testing does not comply with this International Standard.

13 Proof test

13.1 If required by the purchaser or by national regulations, each finished shackle (i.e. after manufacture, heat treatment and machining, including protective coating, if applied) shall be subjected to the appropriate proof force specified in table 3, applied to the crown of the shackle and to the centre of the pin by test machine fittings having a diameter not greater than the actual diameter of the shackle pin.

13.2 After the proof force has been removed, the pin shall show no permanent deformation and, after it has been loosened, it shall turn freely. The actual dimension, *S*, of the shackle shall not increase by more than 0,25 % or 0,5 mm, whichever is the greater.

14 Manufacturer's certificate

14.1 When the type testing as specified in clause 12 has been carried out with satisfactory results, the manufacturer may issue certificates of conformity for shackles of the same nominal dimensions, size, material, heat treatment and method of manufacture, including protective coating, if applied, as the shackles tested.

The manufacturer shall keep a record, for at least 10 years after the last certificate has been issued, of the material specification, heat treatment, dimensions, test results and all relevant data concerning the shackles which have satisfied the type tests. This record shall also include the manufacturing specifications which shall apply to subsequent production.

Any change in material specification, in method of manufacture, including protective coating, if applied, in heat treatment, or in any dimension outside normal manufacturing tolerances which may lead to a modification of the mechanical properties as specified in clause 5 shall be considered as a design change. Tests in accordance with clause 12 shall be required before the manufacturer is permitted to issue certificates of conformity for any modified design.

14.2 If required by the purchaser, the manufacturer or supplier shall provide a certificate with each consignment of shackles, giving the following information for each consignment:

- a) the grade letter, i.e. M(4), S(6) or T(8);
 - b) material details;
 - c) the distinguishing number, to enable any particular shackle or batch of shackles in the consignment to be identified;
 - d) the proof force applied (see clause 13);
- NOTE — This information only applies to shackles which are proof-loaded.
- e) the working load limit.

The certificate shall declare that each shackle complies with this International Standard and is within the manufacturer's specification of the type tested shackle(s). Where relevant, it shall also be stated in the certificate that each shackle was proof loaded in accordance with clause 13, and was subsequently examined by a competent person. It shall also state the name and address of the testing establishment and the status of the signatory.

15 Marking

The body of each shackle shall be legibly and indelibly marked, on parts that are not highly stressed, with at least the following information:

- a) the manufacturer's identification mark or symbol;
- b) the grade letter, i.e. M(4), S(6) or T(8);
- c) the working load limit, e.g. 10 t;
- d) any marking required by national standards, statutory regulations or by agreement between the manufacturer and the purchaser.

The head or tail of each pin shall be marked with the information specified in a), b) and d) above.

16 Designation

For reference and ordering purposes, shackles complying with this International Standard may be designated by the following system.

The following elements shall be used in the order given:

	Shackle	ISO 2415 - X	XX	XX
Identity block (i.e. shackle) _____				
Reference number of this International Standard _____				
Grade of shackle (i.e. M(4), S(6) ou T(8) — either the relevant letter or number may be used) _____				
Type of shackle body _____				
— D: dee shackle body				
— B: bow shackle body				
Type of shackle pin (see figure 3) _____				
— W: screwed with eye and collar				
— X: bolt with hexagon head, hexagon nut and split cotter pin				
— Y: countersunk and slotted head				
— Z: other types (to be described by the manufacturer)				
Nominal size (i.e. WLL in tonnes — see table 2 or 3) _____				

Example 1

A dee shackle, complying with this International Standard, with pin type W, of nominal size 20 t, of grade M(4) shall be designated as follows:

Shackle ISO 2415 - M - DW 20 or **Shackle ISO 2415 - 4 - DW 20**

Example 2

A bow shackle, complying with this International Standard, with pin type X, of nominal size 10 t, of grade T(8) shall be designated as follows:

Shackle ISO 2415 - T - BX 10 or **Shackle ISO 2415 - 8 - BX 10**

Annex

Notes on design

(This annex does not form an integral part of the standard.)

A.1 In 12.3.2 it is stated that the ultimate strength may be calculated provided that shackles with a working load limit of over 63 t are of the same geometrical design as those shackles which have been tested in accordance with 12.3.1. An example of such a method of design which is suitable for use is given in this annex.

A.2 The formula for the bodies of shackles is as follows:

$$d = 36 \left(\frac{WLL \cdot r}{f} \right)^{\frac{1}{3}} - \frac{rW}{9S}$$

where

d is the body diameter of the shackle, in millimetres;

WLL is the working load limit, in tonnes;

r is the internal radius of the bow, in millimetres;

f is the nominal extreme fibre (tensile) stress at the working load limit, in megapascals (newtons per millimetre squared) and is as specified in table 7;

W is the internal jaw width, in millimetres;

S is the internal length of the shackle, in millimetres.

Table 7 — Values for the nominal extreme fibre stress, f

Type of shackle	Values for f for grade		
	M(4)	S(6)	T(8)
	MPa (N/mm ²)		
Dee	315	500	630
Bow	400	630	800

For a dee shackle, it should be noted that $2r = W$.

The formula for the bodies of shackles given above is valid for the following ranges of dimensions:

$$2,5 < \frac{S + \frac{D}{2}}{r} < 6,5$$

$$0,5 < \frac{r}{W} < 1$$

$$0,4 < \frac{d}{W} < 0,75$$

where D is the pin diameter, in millimetres.

A.3 The formula for the pins of shackles is as follows:

$$D = 29,4 \left[\frac{WLL(W + d)}{f} \right]^{\frac{1}{3}}$$

where the notation and units are as for the formula for the bodies of the shackles except that f has the following values:

- M(4): 400 MPa (N/mm²)
- S(6): 630 MPa (N/mm²)
- T(8): 800 MPa (N/mm²)

A.4 The formulae given in clauses A.2 and A.3 were developed at the National Physical Laboratory in the United Kingdom and are based on the condition when the load is at the centre of the pin and the reactions are taken at the centre of the length of the holes. The formulae give minimum values for d and D .

In designing shackles where $d < 25$ mm, the diameter of the pin, D , obtained from the formula should, for practical reasons, be multiplied by a correction factor obtained from the appropriate curve in figure 4 corresponding to the value of $2r/d$.

The formulae give dimensions of shackles suitable for normal conditions of service; for hazardous conditions, shackles should be designed for a reduced nominal extreme fibre (tensile) stress.

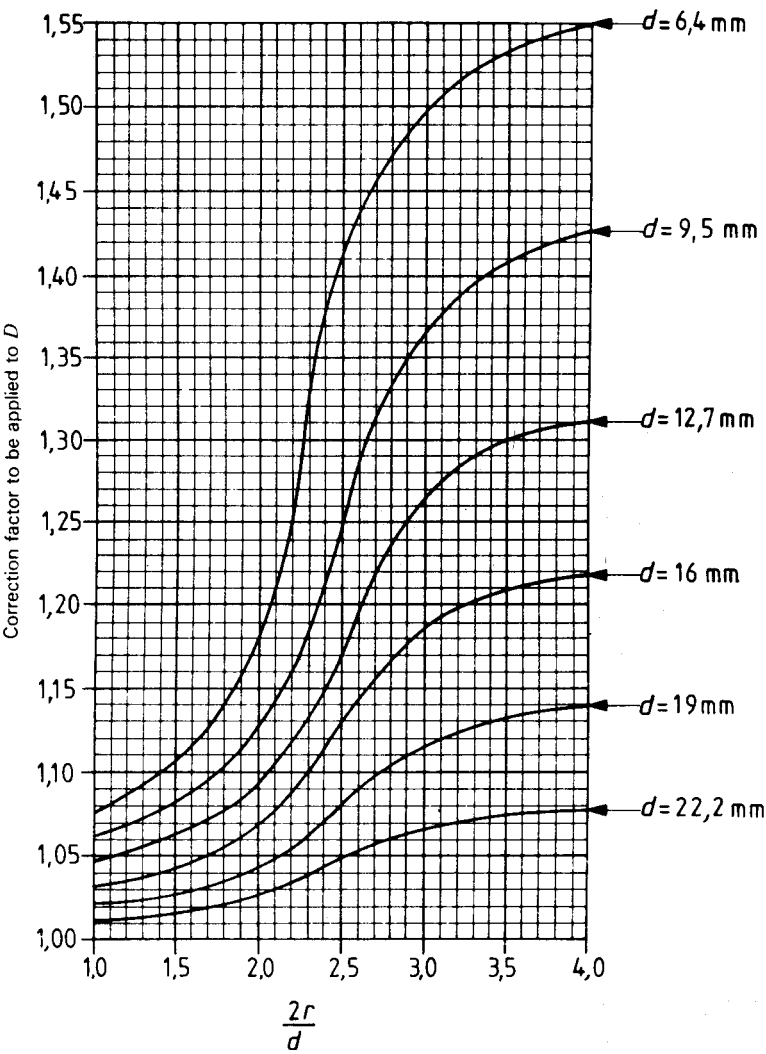


Figure 4 — Correction factor for pin diameters of shackles where $d < 25 \text{ mm}$

(Continued from second cover)

The Technical Committee responsible for the preparation of this standard has reviewed the provisions of the following ISO Standards and has decided that they are acceptable for use in conjunction with this standard:

<i>ISO No.</i>	<i>Title</i>
ISO 263	ISO inch screw threads — General plan and selection for screws, bolts and nuts — Diameter range 0.06 to 6 inches
ISO 4779	Forged steel lifting hooks with point and eye for use with steel chains of grade M(4)
ISO 7597	Forged steel lifting hooks with point and eye for use with steel chains of grade T (8)

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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